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AIR QUALITY

AUGUST 1984



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1983 HAMILTON AIR QUALITY

MINISTRY OF THE ENVIRONMENT

AIR QUALITY ASSESSMENT

TECHNICAL SUPPORT SECTION

WEST CENTRAL REGION

AUGUST 1984

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1. SUMMARY

Air quality in Hamilton in 1983 showed significant improvements over past years. This was due to reduced emissions, the result of reduced industrial production caused by the economic recession and the installation of further control devices at some plants, but also to more favourable weather conditions for the dispersion of pollutants. The improvement in air quality was most apparent in particulate measurements at the two main monitoring stations. The effect on gaseous pollutants was not as significant, probably because most gaseous pollutants measured such as sulphur dioxide and oxides of nitrogen have been recorded at low and acceptable concentrations well within objectives for many years. The concentrations of one gaseous pollutant, ozone, did show a deterioration. This was strictly a weather related phenomenon, owing to a warmer, more sunshine-filled summer.

The Air Pollution Index reached the advisory level of 32 on only one occasion compared to 13 times in 1982. The improvement was due both to favourable weather conditions, namely a lack of severe inversion conditions which have notably affected Hamilton air quality over the years and to a lesser extent, the reduced industrial emissions.

The network of high volume samplers measuring suspended particulates generally showed lower levels, probably due both to the reduced emissions and favourable weather.

Dustfall jars located throughout the city to measure heavy settleable dust, showed no significant change from previous years.

The network of fluoride monitors indicated lower concentrations in the industrial area. However, the remainder of the network was unchanged.

2. INTRODUCTION

The Air Management Program in Ontario is based on controlling man-made emissions to meet ambient air quality objectives, which in turn are based on known effects on health, quality of life or sensitive vegetation, whichever is most stringent. To achieve these objectives, sources of pollution are identified, their emissions evaluated and appropriate control measures are instituted. Ambient air monitoring is then used to verify that the controls have been successful. Monitors are mainly sited in areas suspected of experiencing higher levels of air pollution. If and when these areas achieve acceptable air quality, then other areas should also be acceptable.

3. MONITORING NETWORK

The Ministry of the Environment operates a network of ambient air monitors throughout Hamilton as shown in Figure 1. Monitoring is concentrated in the lower city, i.e., the area below the Niagara Escarpment. The network is centered on two major stations which monitor a variety of pollutants with automated analyzers. The main station, known as 29025 - Barton/Sanford provides the data which forms the basis for the Hamilton Air Pollution Index (API). The other major station is on the Beach Strip and is known as 29008 - North Park, immediately adjacent to the Queen Elizabeth Way. The remainder of the network consists of numerous but less sophisticated monitors. Most of the network has been in existence since at least 1970. In addition to this regular network, special surveys are carried out on occasion in order to identify specific problems.

Meteorological data (wind speed, wind direction and air temperature) are observed at station 29026, located on the sewage treatment plant grounds on Woodward Avenue. This location is probably more representative of local conditions than the Federal Government's Mount Hope Weather Station due to the complex meteorological patterns which sometimes prevail in Hamilton.

The results of a computer program known as a "pollution rose" are included in this report. The program is essentially a cross-tabulation of hourly pollutant concentrations (measured at the two main stations) with wind speed and direction. (Only direction is considered in the report for simplicity). The program is a useful tool in source identification of pollutants. The total annual percentage effect of concentrations originating from a certain wind direction depends of course on the frequency of winds from this direction.

4. ANALYSIS OF DATA

4.1 Air Pollution Index

The Hamilton air pollution index (API) is used as a warning system to alert the public to elevated air pollution levels. It is derived from 24 hour average concentrations of sulphur dioxide and particulate matter as measured at the Barton/Sanford Station. The combination of these two pollutants at elevated levels has been shown to be at least indicative of detrimental human health effects. No action is taken for readings up to 31. At 32, known as the advisory level, and with a forecast of unfavourable dispersion conditions, major point source emitters are notified and asked to voluntarily curtail certain operations. At an API of 50, cutbacks by these sources become mandatory. These levels are set with a considerable safety margin before health effects to sensitive people would be expected.

The API station is located at the interface between the heavy industrial and residential areas of the city and about half-way between downtown and the integrated steel mills. It is directly downwind of the industrial area during times of poorest atmospheric dispersion. Due to differences in station locations in relation to local sources, inter-city API comparisons between cities are rather tenuous and therefore, should not be made.

During 1983, there was only one incident on March 1-2, in which the API reached 32 as shown in Table 1. Temperatures were very mild (8 - 10 °C above freezing) in Southern Ontario due to a flow of warm southerly winds. However, in Hamilton, the warm flow was undercut by a colder lake breeze, creating a temperature inversion. Pollutant levels were elevated throughout Southern Ontario, and, the lake breeze made Hamilton's air quality worse.

The single incident is in marked contrast to previous years which have recorded anywhere from 5 to 22 incidents as shown in Table 1. The variation from year to year is mostly weather-related depending on the frequency of inversions, more so than changes in industrial emissions. For instance, emissions in 1982 were also reduced, similar to 1983, however there were 13 API incidents during that year.

This is not to say that there was only one inversion in 1983. There were several others, but those lacked either the intensity or were of insufficient duration to cause the API to reach the advisory level.

4.2 Particulates

There are three basic types of instruments employed for the measurement of particles, each type relating to a different

size range: (a) Dustfall jars measure heavy material, generally greater than 10 microns in diameter (one micron is one-millionth of a metre). (b) High volume samplers measure suspended particulates ranging in size from submicron to 50 microns and (c) Co-efficient of haze tape samplers measure mostly fine material - from submicron to about 10 microns.

The ambient air quality objectives for suspended particulate are based on health effects when occurring in combination with sulphur dioxide. As mentioned previously, this combination was proven to be indicative but not necessarily causative of such health effects. The dustfall objectives are based on nuisance effects while the soiling index objectives were chosen arbitrarily.

4.2.1 Total Suspended Particulates

A high volume sampler draws a known volume of air through a pre-weighed filter for a 24 hour period (midnight to midnight). The exposed filter is weighed and the difference (weight of solids on filter) in conjunction with the known air flow is expressed as a concentration in micrograms per cubic meter. At two locations in Hamilton, these devices operate daily. At eleven other locations, they run on a once every sixth day cycle, consistent with the practice in other North American jurisdictions.

The network shows a definite gradient of higher concentrations closer to the industrial area. Concentrations generally were slightly lower compared to 1982, probably due both to the lower frequency of inversion conditions and further reduced industrial emissions. Elevated concentrations continued to be observed close to the industrial area (29011). Downtown levels were only marginally above the yearly objective while in the east and west ends and on the mountain, levels were below the yearly objective.

A small pocket of elevated concentrations also exists in a small manufacturing area in the west end near the Main Street - Highway 403 area (29017).

Pollution roses for suspended particulates were manually calculated for the two main stations by grouping the data according to predominant daily wind directions (as opposed to the hourly pollution rose computer program which classes hourly data). Only those days for which a clear predominant direction could be determined were included and rainfall/snowfall days were excluded (Figures 13 and 14).

Both roses indicate a strong correlation of high averages with winds from the industrial sector.

However, other sectors can make significant contributions as well. At Barton Street, the elevated average for southwest winds (75 ug/m^3) indicates an influence by very local sources such as traffic on Barton Street.

The hi-vol filters were analysed for seven metals, as well as sulphates and nitrates. The data is tabulated in Table 2c.

Concentrations of nickel, cadmium, lead and vanadium showed very low concentrations which did not vary appreciably throughout the city indicating that these were background levels. The 24 hour criteria for these metals were easily met.

Concentrations of chromium and manganese were somewhat higher and showed a gradient with distance from the industrial area. However, the highest levels were well below acceptable levels.

Iron concentrations were high, and also showed a gradient with distance from the industrial area where concentrations were generally well above guidelines.

The sulphate/nitrate components comprised a large portion of the measured particulate matter. These constituents are largely by-products of major high temperature fuel combustion sources and can travel hundreds of miles from their source. The concentrations in Hamilton are generally uniform with moderately higher levels found in the industrial area, indicating a contribution from local industries. Elevated concentrations at most of the stations (other than North Park) during northeast winds, confirms this. However, most of the city shows levels only moderately higher than other areas in the province including rural areas, indicating that much of this material is imported into the city via long range transport from distant sources. The sulphate/nitrate components are known to be a factor in reduced visibility and are often responsible for the widespread haze observed in Hamilton during southerly winds.

It should be noted that the sulphate/nitrate analyses are subject to some error due to the measurement methodology. Atmospheric sulphate data obtained with the high volume sampler/glass fibre filter combination are subject to a positive error which can be substantial. The error is due to the conversion of gaseous sulphur dioxide to particulate sulphate by the filter medium. Various factors affect the conversion rate, but the spurious formation is largest in winter and least in summer.

The nitrate data are also imprecise to a variable extent due to the occurrence of both positive and negative interferences. The error can be substantial. The positive interference is due to adsorption of gaseous nitric acid from the sampled air by the filter medium or, to a lesser extent, oxidation of nitrogen dioxide to nitrate by the filter medium. The negative interference is caused by the reaction of co-collected sulphuric acid with particulate nitrate to release nitric acid.¹

For the reasons stated above the sulphate and nitrate data presented should be primarily used for evaluation of trends rather than use of the actual values. Alternative methodologies and filters are under investigation to avoid spurious results in future.

McMaster University also continued hi-vol sampling as part of their study on the health effects of air pollution. Their sampling coincided with the Ministry sampling schedule, making their network of 11 hi-vols a useful supplement to ours. The samplers are mostly situated in residential areas on the mountain and far ends of the city and most recorded very low concentrations, generally within objectives (Table 2b) and slightly lower than 1982 levels, similar to the Ministry network.

The large dual network makes it possible to draw a contour map of suspended particulate concentrations, given in Figure 2. It can be seen that the majority of the city meets the yearly objective of 60 ug/m³.

Concentrations are elevated close to the industrial area and in the small pocket of light manufacturing near Main Street and Highway 403 previously mentioned.

1 Environment Canada, Environmental Protection Service, "The Sampling and Analysis of Airborne Sulphate and Nitrates: A Review of Published Work and Synthesis of Available Information", Surveillance Report EPS 5-AP- 82-14, Air Pollution Control Directorate, March 1981, p. vii.

4.2.2 Soiling Index (Co-efficient of Haze)

Co-efficient of haze tape samplers operate continuously and determine hourly soiling values. Air is drawn through a filter paper, and the optical density of the soiled spot is measured by light transmittance. The instrument has readings taken prior to and after sample collection. The resultant light obstruction is determined and transmitted on a real time basis to the data bank.

The main stations on Barton Street and North Park both employ these instruments (Table 3). Despite a substantial decrease in industrial emissions, North Park's annual mean was similar to 1982, marginally above the yearly objective but substantially lower than in previous years.

Barton Street showed a huge improvement in its yearly mean, falling below the yearly objective. The improvement was due both to lower industrial emissions and favourable weather conditions. The relative absence of inversions in 1983 was reflected in only 13 days exceeding the daily objective as compared to 41 days in 1982.

Soiling index pollution roses given in Figures 15 and 16 indicate that the industrial area is the prime source of fine particulates at both major stations, i.e. northeast quadrant winds for Barton and southwest quadrant winds for North Park show the highest averages. Traffic emissions from the QEW seemed to be affecting the readings at North Park. The soiling index for industrial winds (southwest) at North Park is much higher than for Barton (northeast). Under southwest winds, North Park is downwind of both industry and the highway. Traffic also affected readings at Barton St. as shown by the elevated southeast average (from the Barton/Sanford intersection). Both stations consistently showed peaks at rush hours, particularly the morning rush hour, when the air is still stable with little wind.

4.2.3 Dustfall

Dustfall is that material which settles out of the atmosphere by gravity, and is collected in plastic containers during a 30 day exposure time. The collected material is weighed and expressed as a deposition rate of grams/square meter/30 days. The significance of observations is restricted to relatively local areas.

Dustfall levels in 1983 (Table 4) remained similar to those of previous years. Figure 3 depicts dustfall isopleths, and shows that a small portion of the lower city and the Beach Strip near the industrial area was encompassed by the $9.0 \text{ grams/m}^2/30 \text{ days}$ contour which represents twice our objective. Conditions in this area, for the most part were quite poor. Two stations in the east end recorded means below the yearly objective of 4.5 grams. Close examination of Table 4 reveals that dustfall in the central portion of the city and on the mountain was reduced in the final half of the year compared to the first half. This is probably due to a corresponding reduction in inversion conditions verified by vertical temperature difference data at the Woodward Avenue meteorological station.

Dustfall objectives are based on unacceptable visible deposit of dust on surfaces rather than health effects. The levels throughout the city have remained virtually unchanged throughout the 1970's; a puzzling observation considering the considerable reductions in industrial process emissions and the correspondingly large reductions in suspended particulate concentrations noted in Figure 4. Fugitive dust sources such as uncontrolled stock piles, excavation and construction, vehicular emissions, road dust, unpaved lots susceptible to wind erosion, etc. are probably important in explaining this observation.

Road traffic is a major source of the dust at several of the stations. For example, the North Park station records higher loadings on average than another location on Beach Blvd. (29084) only two blocks away. Road traffic emissions from the Q.E.W. are likely responsible. As well, the location on Concession Street (29031) at Upper Sherman records higher than expected loadings, probably due to the heavy traffic which passes directly by the station. On Ottawa Street (29010) the continuing construction of a new hot strip mill at Dofasco has resulted in extremely high concentrations which are probably due to the increased heavy truck traffic and the construction activities themselves. Observations at the base of Strathearn Avenue (29037) are also severely affected by an unpaved, dusty and well travelled path immediately beside the station. This location has recorded extremely high loadings throughout its history, mostly due to this dusty road. The lower loadings during the winter months when the ground is frozen or snow-covered attest to this.

4.3 Sulphur Dioxide

Most sulphur dioxide (SO_2) emissions in Hamilton, as detailed by the emissions inventory, stem from industrial sources. Only a small portion is accounted for by fuel burning in domestic space heating. The Barton/Sanford and North Park stations monitor SO_2 continuously and data is summarized in Table 5.

Sulphur dioxide trends from the two stations since 1970 are illustrated in Figure 5. In 1983, as in the past several years, the concentrations were acceptable, within the yearly objective and there were no readings above the hourly or daily objectives. These objectives are based on vegetation damage; a more stringent limitation than human health effects. The pollution roses for the two stations given in Figures 17 and 18 confirm that the industrial area is the prime source of SO_2 in the city.

4.4 Total Reduced Sulphur

This measurement is comprised mostly of hydrogen sulphide (H_2S), the "rotten egg" gas. However, since the analyzer also reacts to other sulphur compounds, the data is referred to as total reduced sulphur (TRS). The objective for hydrogen sulphide may still be applied to the observed values and is based on the odour threshold level. Both Barton/Sanford and North Park monitor this pollutant continuously and the data are summarized in Table 6.

The major sources of hydrogen sulphide and related sulphur compounds are the steel industry's coke ovens, certain slag reclamation processes and under upset conditions, a local manufacturer of carbon black. The sewage treatment plant is another potential source of odours but only during certain upset conditions.

Yearly trends for the two stations are illustrated in Figure 6. In 1983 TRS concentrations at Barton were similar to 1982 with 30 exceedences of the hourly objective for H_2S compared to 32 in 1982.

Concentrations at North Park were significantly lower on average than in previous years with only 9 exceedences of the hourly H_2S criterion. The differing trends at the two stations are not readily explained except that yearly averages consisting of very low levels interspersed with sporadic elevated concentrations may render any "trend" as insignificant.

The Barton incidents of elevated concentration usually occurred during very light northeast winds during non-winter months. The North Park incidents occurred during southwesterly winds and also during non-winter months. Not

surprisingly, the TRS pollution roses for the two stations given in Figures 19 and 20 both point strongly toward the industrial area.

4.5 Carbon Monoxide

X { The major source of carbon monoxide is the automobile. However, in Hamilton there are also some contributions from industry. Due probably to automotive emission controls, the levels measured at Barton Street (Table 7) decreased greatly over the 1970-75 period and have stabilized since. (Figure 7). In 1983, the levels were similar to the previous few years and were well below the objectives which are based on health effects.

The pollution rose given in Figure 25 indicates that southeast quadrant winds (from the intersection of Barton and Sanford Streets) followed by northeast quadrant winds (from industry) yield the highest averages.

4.6 Oxides of Nitrogen

The primary source of oxides of nitrogen are high temperature combustion sources including the automobile. The most abundant oxides are nitric oxide (NO) and nitrogen dioxide (NO₂), and they are monitored continuously at both Barton/Sanford and North Park. At each station, a single instrument makes measurements of NO, NO₂ and total nitrogen oxides. Nitric oxide is measured directly, and the total oxides are measured by internally converting all other nitrogen oxides to nitric oxide. The instrument then determines nitrogen dioxide to be the difference between the first two measurements.

Objectives exist only for nitrogen dioxide and these are based on odour threshold levels (hourly) and health effects (24-hourly). Other deleterious effects include vegetation damage, reduced visibility and corrosion of metals. The objectives were not exceeded at either station in 1983.

Data for nitrogen dioxide and nitric oxide are given in Tables 8 and 9, and yearly trends since 1975 are illustrated in Figures 10 and 11. Both stations showed similar concentrations to previous years, although nitric oxide at Barton was somewhat lower compared to 1982.

Pollution roses for the two measurements are given in Figures 21-24. The roses for NO₂ both seem to indicate an equal contribution from industry and traffic. However, the NO levels at both stations were due mostly to traffic. This is best shown by the fact that while NO₂ levels were comparable at the two stations, NO levels were three times as high at North Park than at Barton. This is probably explained by North Park's proximity to the QEW. Most vehicular emissions

of oxides of nitrogen consist of NO which later is oxidized to NO₂ in the atmosphere. Under normal circumstances the North Park station probably monitors the NO before this conversion can fully take place. The pollution rose (Figure 23) confirms this as the highest NO average occurs under northwest winds (i.e. exclusively from the highway). The Barton NO rose (Figure 24) also peaks under southeast winds (from the intersection of Barton/Sanford).

Oxides of nitrogen are an important factor in the photochemical production of ozone which will be discussed in the next section of this report.

4.7 Ozone

Oxidants are produced by photochemical reactions involving oxides of nitrogen, hydrocarbons and sunlight. Ozone accounts for most of the oxidants produced. The sources of the precursor pollutants are mainly industrial and automotive.

Ozone is known to be associated with many respiratory problems, and at elevated concentrations, people can experience adverse health effects. Ozone is also injurious to different types of vegetation including certain tobacco and tomato crops. The one-hour objective for ozone (.08 ppm) is based on vegetation effects, however, ozone can also have detrimental human health effects at only slightly higher levels.

Ozone concentrations follow very definite annual and daily trends. Highest levels occur during the summer (May - September), and the daily maximums usually occur during mid-afternoon. Both patterns are directly related to temperature and the amount and intensity of sunlight.

Ozone is measured at the Barton Street station, and data is summarized in Table 10 while yearly trends are illustrated in Figure 8.

In 1983, concentrations on average were higher than in recent years, recording 61 hours above the hourly objective during the June - September period, compared to only 4 hours in 1982. The deterioration is reflective of a warmer summer with a higher than normal amount of bright sunshine (as per Mount Hope weather records). The higher concentrations when they occurred, were widespread, occurring concurrently throughout Southern Ontario during periods of southerly or southwesterly winds which implies their origin to be in the United States.

The pollution rose in Figure 26 confirms that highest concentrations occur under winds from the southwest quadrant. Since the rose is computed for the entire year,

the non-peak periods of the year tend to reduce the size of this southwest peak.

Ozone, hydrocarbons and oxides of nitrogen can be transported over great distances and can be augmented by local sources. However, Hamilton and other major urban areas usually experience lower ozone concentration than their more rural surroundings during peak occurrences. In fact, the concentrations in Hamilton are among the lowest recorded in Southern Ontario, probably due to the numerous high temperature combustion sources which produce scavengers of ozone. Nonetheless, ozone and other oxidants remain a problem which, due to the complexity of their formation and the long range transport phenomenon, will have to be resolved on a regional rather than local scale.

4.8 Fluoridation

This measurement is a crude assessment used to determine relative quantities of various fluoride compounds in the ambient air. A lime coated paper is exposed to the atmosphere for approximately 30 days and is then chemically analyzed for fluoride. The fluoride objectives are based on vegetation damage and for this reason, the objective is more stringent during the growing season. For the period of April 15 to October 15, it is 40 micrograms/100 square centimeters/30 days while for the remainder of the year it is 80.

In Hamilton, the major fluoride sources are the basic oxygen furnaces used by the major steel industries which require fluorspar as a fluxing agent. In addition to these process emissions, there are other minor sources such as coal burning, since coal contains trace amounts of fluoride. A brick manufacturing plant at the base of the escarpment near Gage Park is the only non-steel industry source.

Data for 1983 is summarized in Table 11 and the yearly trend since 1970 is illustrated in Figure 9.

The trend graph shows that levels have remained relatively stable since 1974 following large reductions in concentrations which began in 1971.

In 1983, consistently elevated concentrations continued to be observed on the Beach Strip (29058) and at Burlington/Gage (29059) near the main fluoride sources. However, levels were lower at these locations compared to previous years, due to reduced industrial emissions.

The remaining stations showed only occasional and marginal exceedences of the objectives. Based on past vegetation studies, it is unlikely that even the highest measured levels have affected local plant life. One station on King Street

East near Kenilworth (29062) near the brick plant previously mentioned, continued to record lower concentrations compared to previous years as it did in 1982, probably relating to a substantial decrease in production at this plant throughout the year.

5. DISCUSSION

The main pollution problem in Hamilton, apart from heavy dust fallout in the industrial area, is short-term pollution buildups during the spring and fall due to the presence of temperature inversions. During 1983, industrial production in Hamilton was further reduced compared to previous years due to the economic recession. Many smaller plants were shut down and larger ones were operating at reduced capacity. As a result and in conjunction with improved pollution controls at some plants, industrial emissions were down substantially. This emission reduction was evident in reduced particulate concentrations at both main monitoring stations as well as at the other high volume samplers throughout the city. In addition, due to favourable weather conditions, specifically a lack of temperature inversions, the Air Pollution Index reached the advisory level of 32 only once during 1983 compared with 13 occurrences in 1982. Since emissions of pollutants during both years were reduced due to the economic recession, the significance of weather variability becomes evident. The city's unique topography simply makes it very susceptible to inversions during which times pollution buildups are unavoidable, and therefore, such incidents are likely to recur in the future.

Although industrial emissions were substantially reduced in 1983, data indicates that the industrial area was still a major source of airborne dust. The reductions in average pollutant concentrations at the two main stations during a year of reduced emissions indicate that overall air quality improvements through further industrial abatement might still be achieved to some degree. However, the remaining pollution sources are difficult to control and in some cases control technology does not exist. Work is ongoing in attempts to control these sources better through existing Control Orders. As well, other pollution sources on which no emphasis has yet been placed will also require control wherever possible. These sources can be both industrial and non-industrial in nature, such as blowoff from unpaved areas, excavation, construction, demolition, road traffic, stock piles and other non-stack industrial emissions.

6. Acknowledgment

We would like to thank Mr. Stephen A. Toplack of the Urban Air Environment Group at McMaster University for providing their suspended particulate data.

FIGURE 1
HAMILTON AIR MONITORING
NETWORK

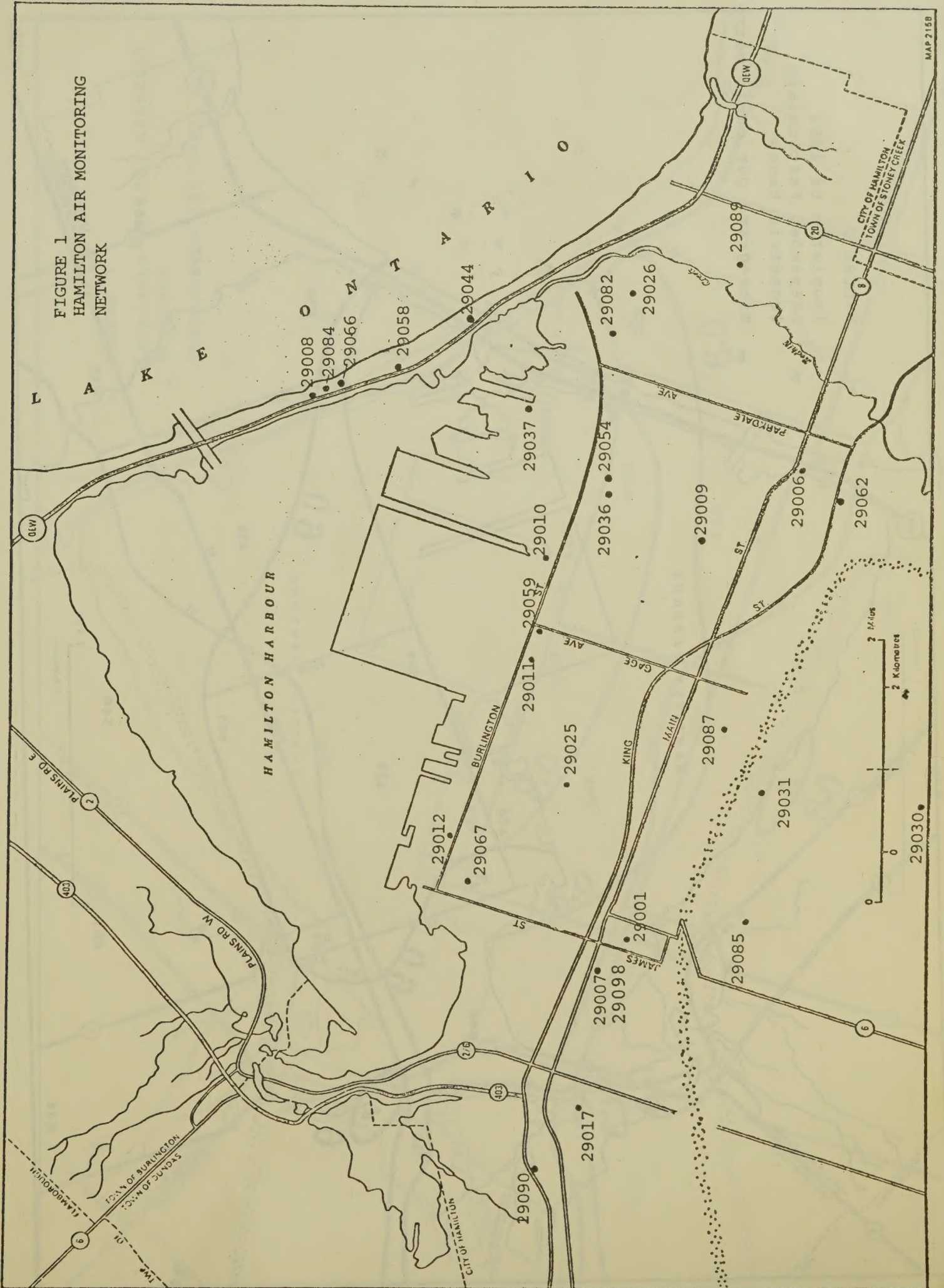


FIGURE 2

Isopleths of 1983
Suspended Particulate
Geometric Means

Micrograms per cubic metre

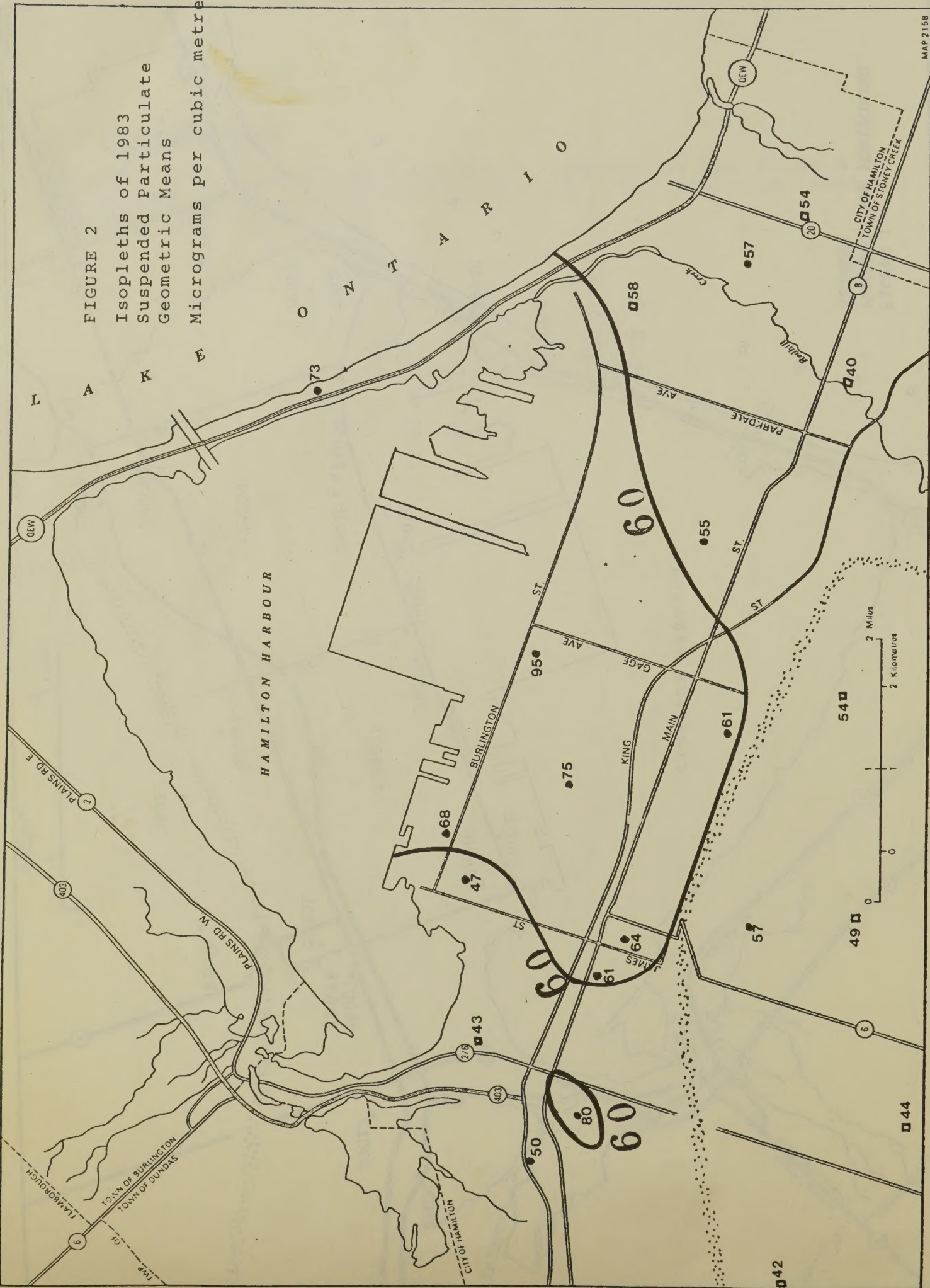


FIGURE 3
Isopleths of 1983 Dustfall
Averages
Grams/metre²/30 days

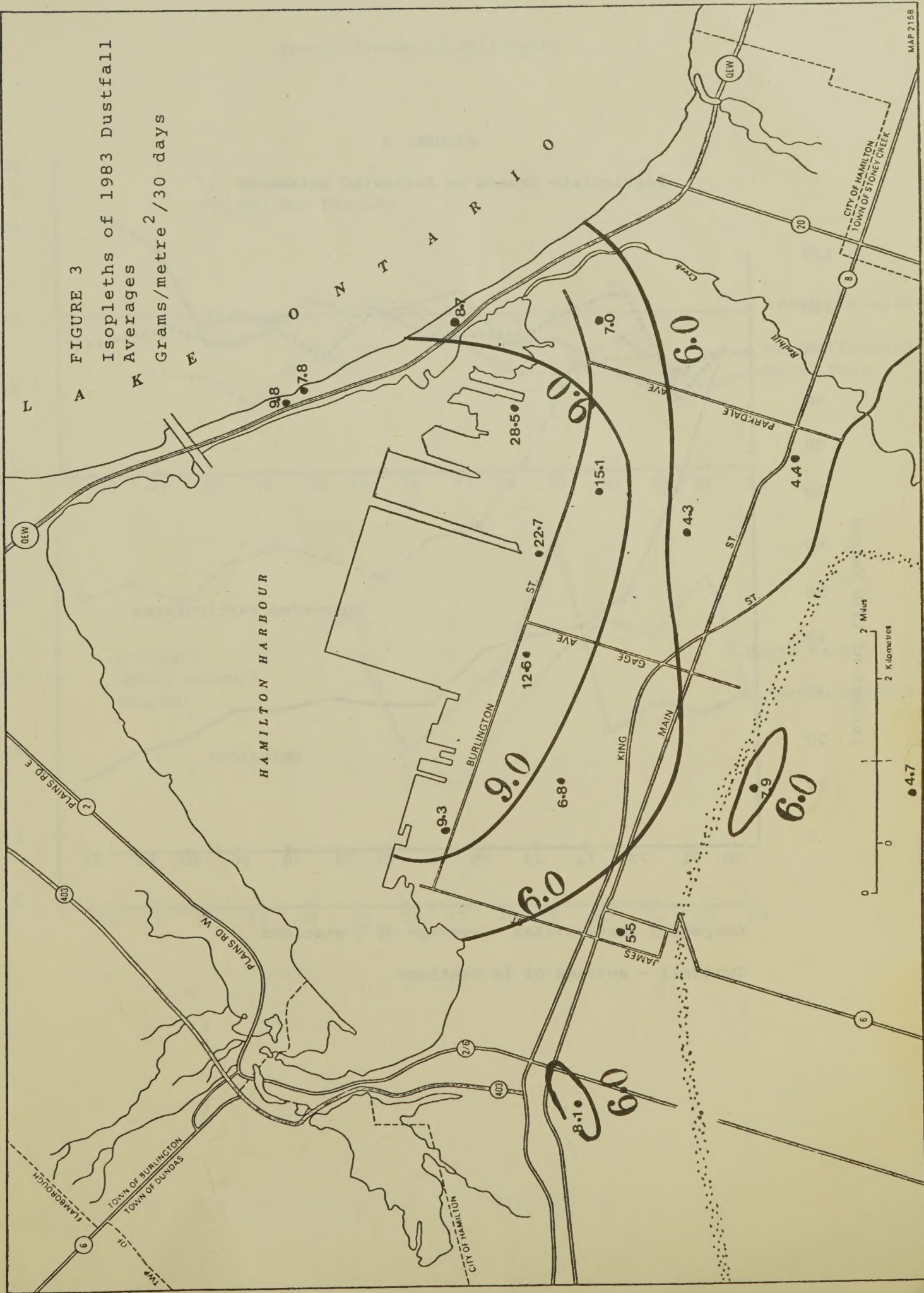
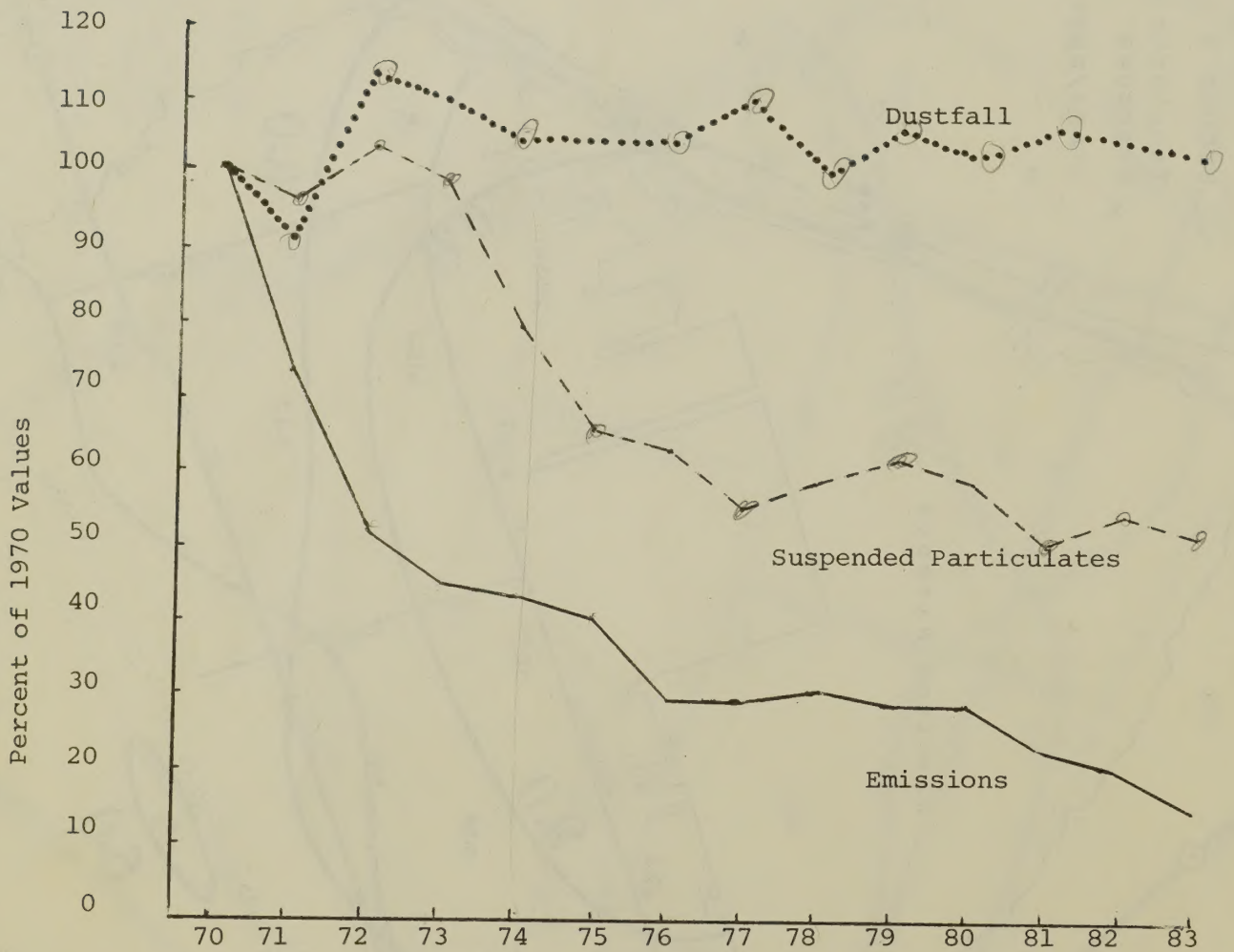


FIGURE 4

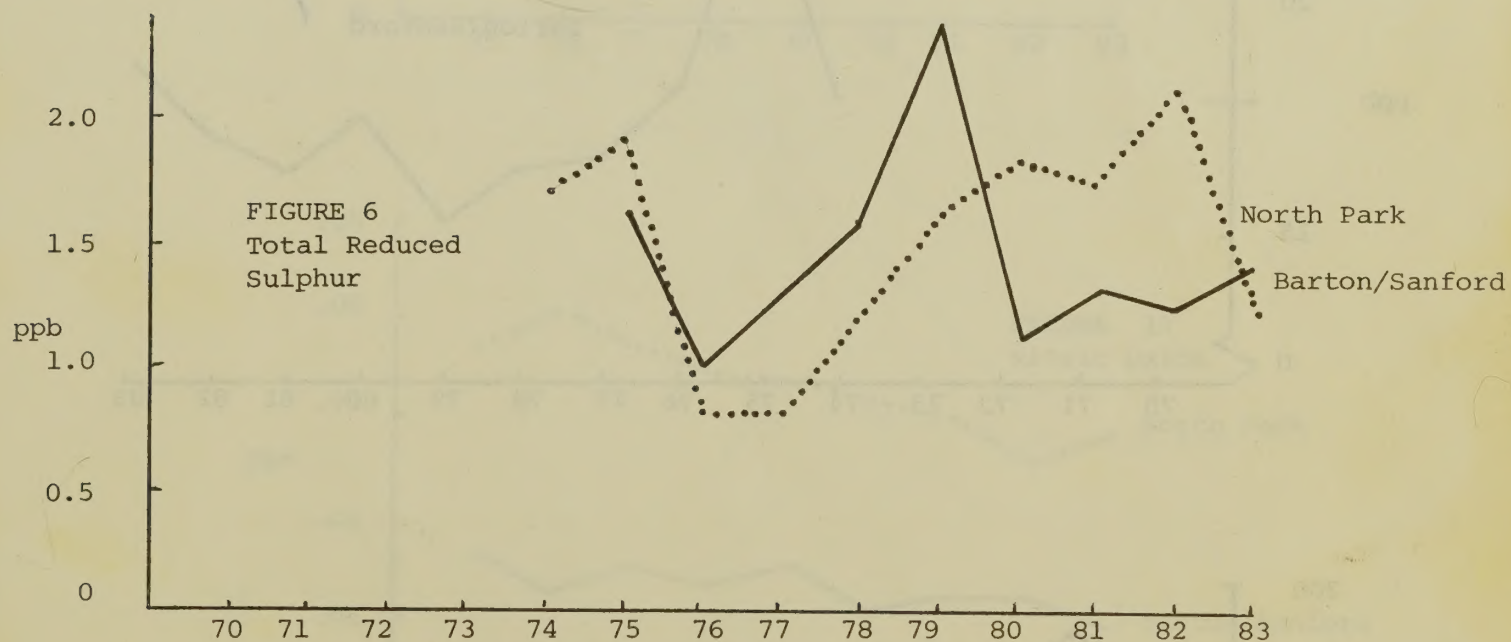
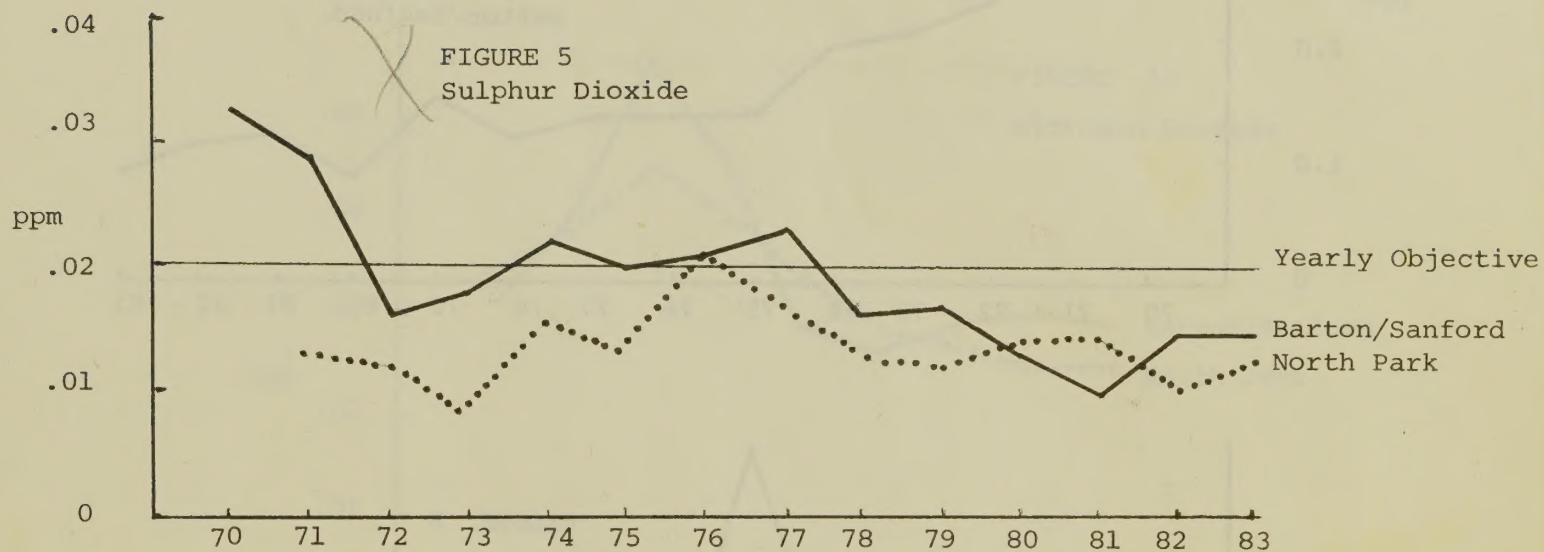
Particulate Trends vs Estimated Emissions



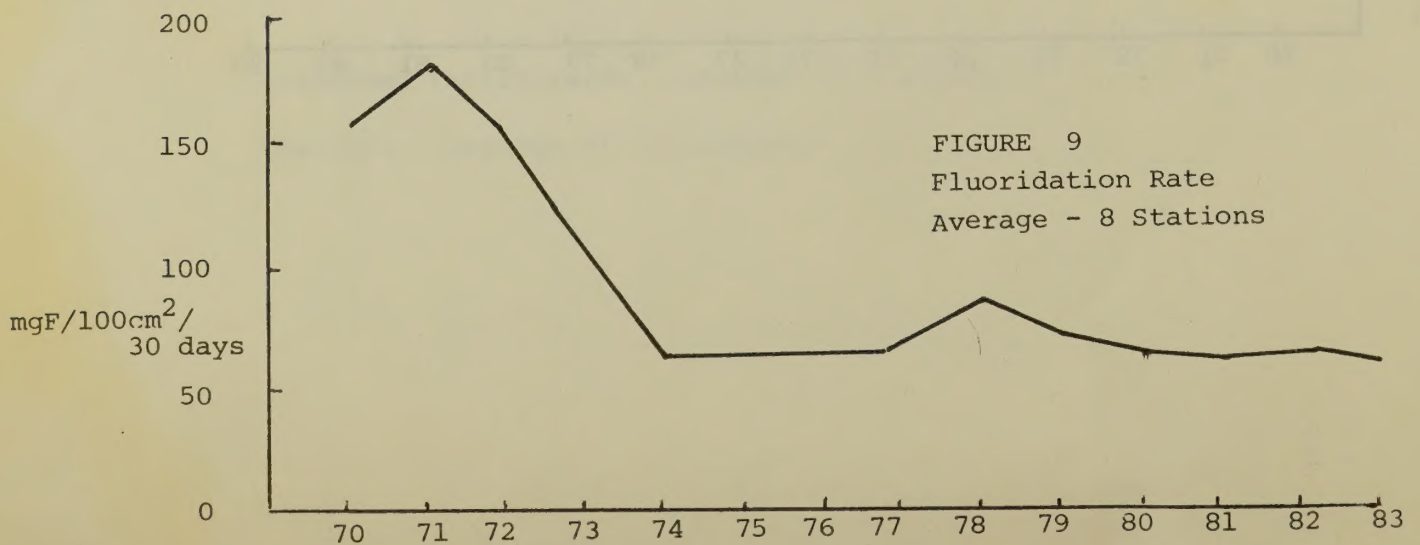
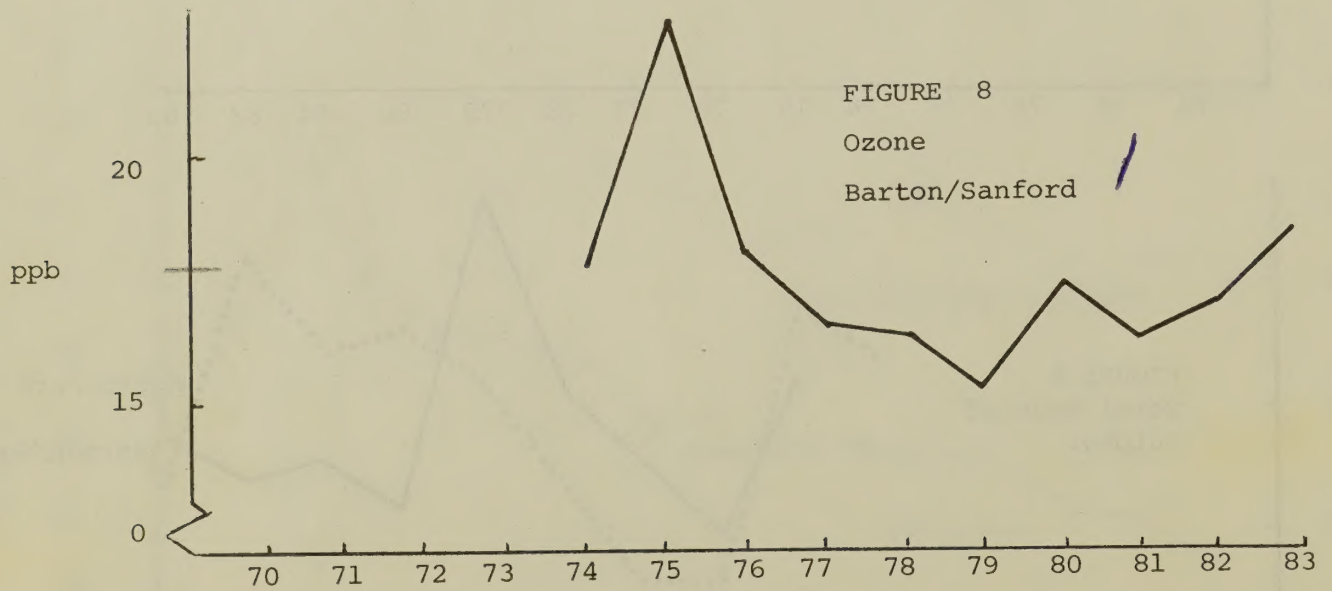
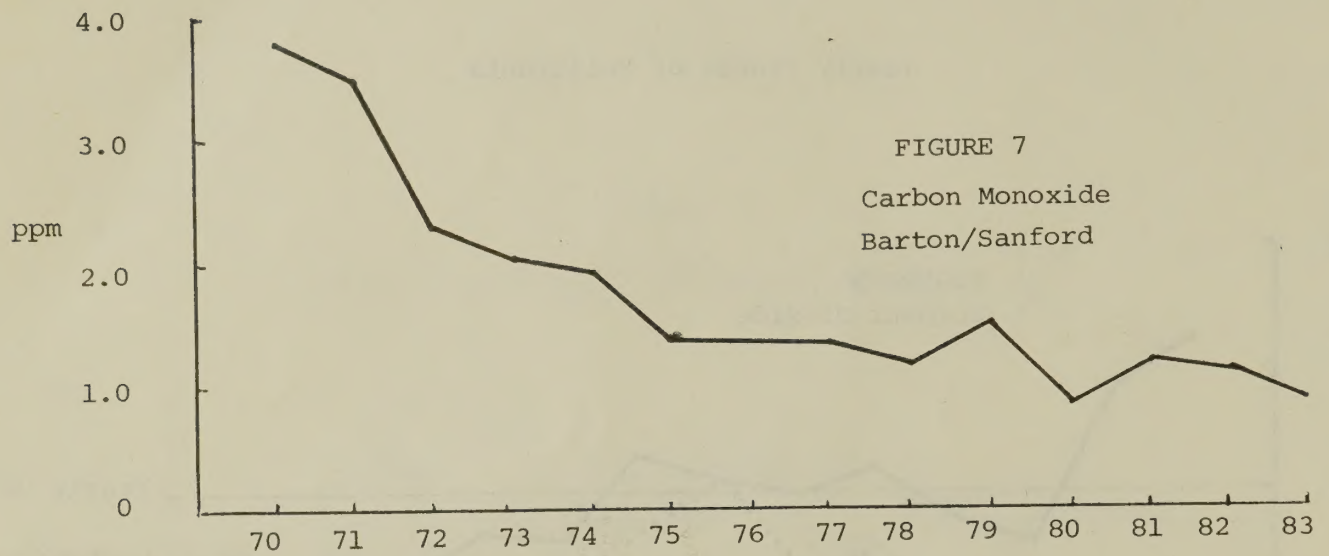
Suspended Particulates - average of 7 stations

Dustfall - average of 14 stations

Yearly Trends of Pollutants



- 22 -
Yearly Trends of Pollutants



Yearly Trends of Pollutants

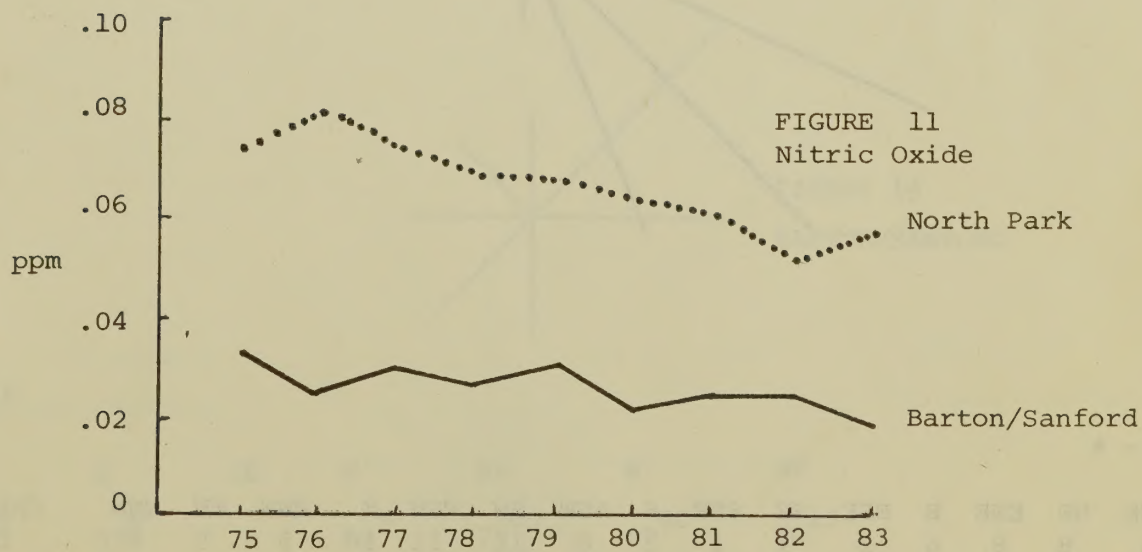
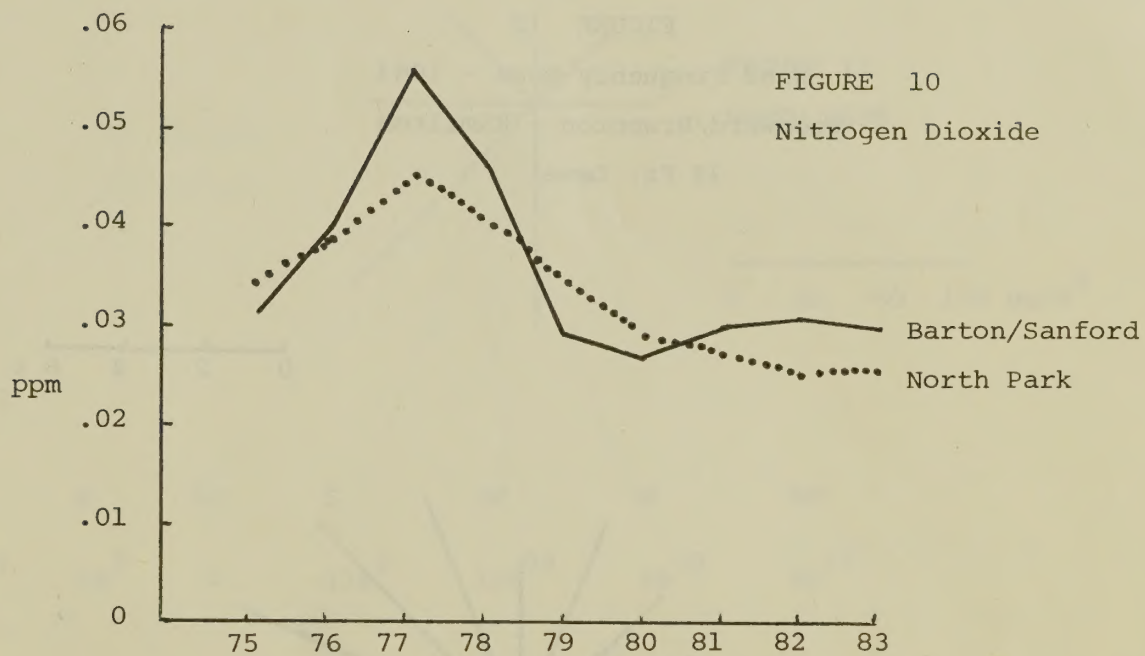
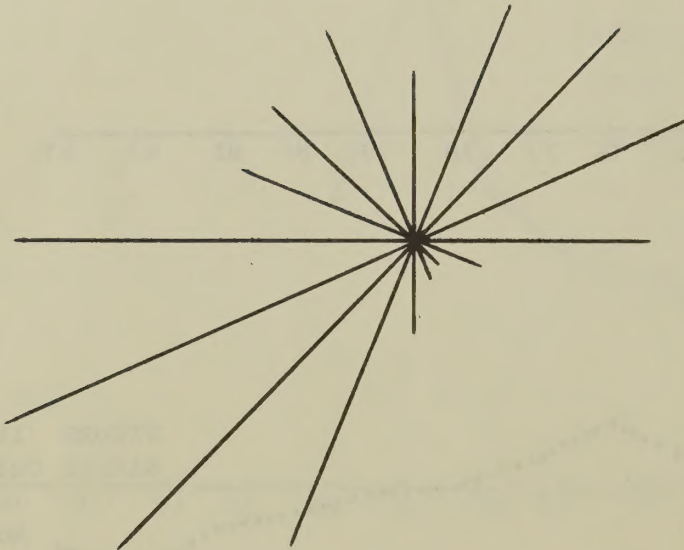


FIGURE 12

Wind Frequency Rose - 1983
Woodward/Brampton - Hamilton
33 Ft. Level

0 2 4 6 %



Unit - %

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	CALM
4	6	8	8	6	2	1	1	2	8	11	11	10	5	5	6	6

POLLUTION ROSES - SUSPENDED PARTICULATES - 1983

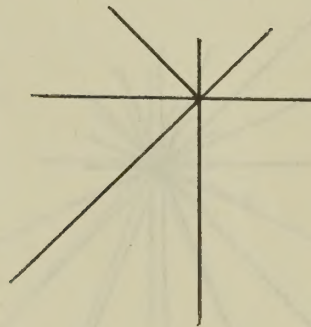


FIGURE 13
NORTH PARK

Unit - $\mu\text{g}/\text{m}^3$

N	NE	E	SE	S	SW	W	NW
32 ⁷	50 ³⁶	58 ⁷	-	116 ⁵	136 ⁶⁴	86 ³⁹	66 ¹⁵

Exponents refer to number of samples. Means are arithmetic.

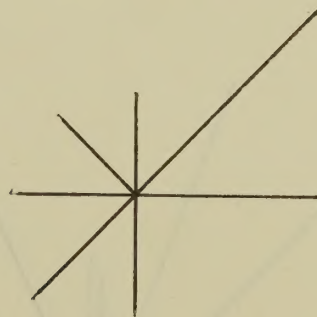


FIGURE 14
BARTON/SANFORD

Unit - $\mu\text{g}/\text{m}^3$

N	NE	E	SE	S	SW	W	NW
53 ⁹	134 ³¹	97 ⁶	-	64 ⁵	75 ⁶⁰	62 ⁴⁰	60 ¹⁵

POLLUTION ROSES - SOILING INDEX - 1983

0 .2 .4 .6 COH's/1000 ft

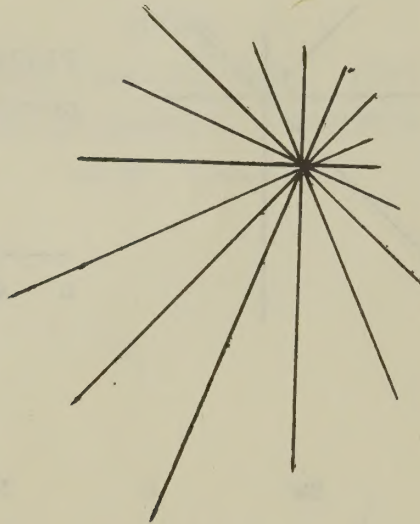


FIGURE 15
NORTH PARK

Unit - .01 COH's/1000 Ft.

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
29	27	23	19	20	26	42	64	79	98	85	81	57	51	58	35

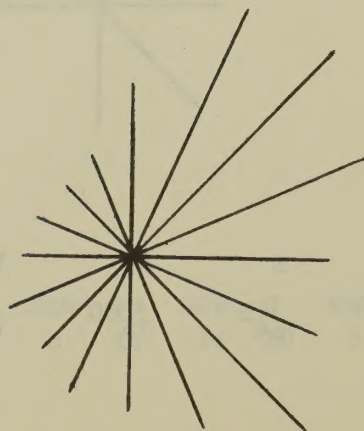


FIGURE 16
BARTON/SANFORD

Unit - .01 COH's/1000 Ft.

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
44	69	73	65	51	51	63	47	39	38	33	34	27	26	24	28

POLLUTION ROSES - SULPHUR DIOXIDE - 1983

0 5 10 15 ppb



FIGURE 17
NORTH PARK

Unit - ppb

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
6	4	4	5	5	7	5	10	13	24	30	18	7	5	5	5

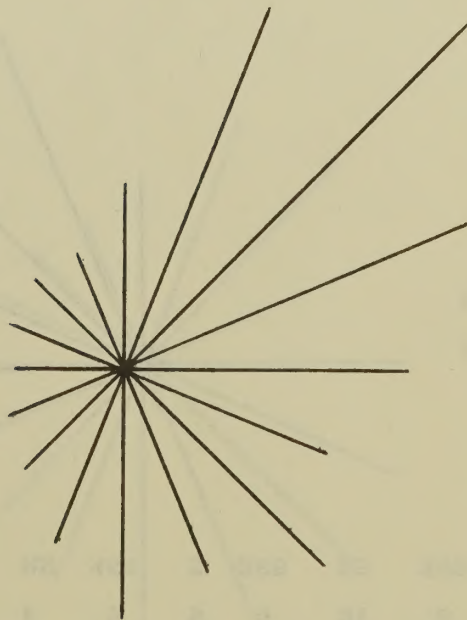


FIGURE 18
BARTON/SANFORD

Unit - ppb

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
12	25	31	24	18	14	18	14	16	12	9	8	7	8	8	8

POLLUTION ROSES - TOTAL REDUCED SULPHUR - 1983

0 1 2 3 ppb



FIGURE 19
NORTH PARK

Unit - .1 ppb

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
4	4	4	3	4	4	7	11	17	23	26	24	12	6	4	5



FIGURE 20
BARTON/SANFORD

Unit - .1 ppb

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
24	47	36	31	19	9	10	6	6	6	3	3	3	3	4	9

POLLUTION ROSES - NITROGEN DIOXIDE - 1983

0 10 20 30 ppb

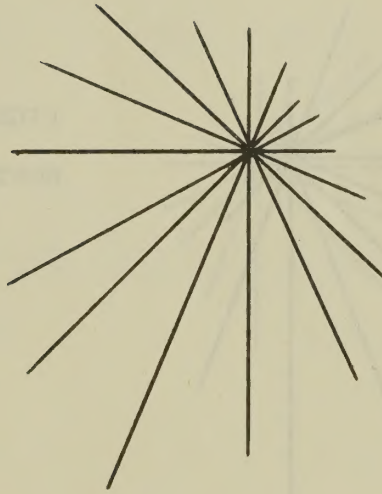


FIGURE 21
NORTH PARK

Unit - ppb

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
16	12	9	10	11	16	23	32	39	47	40	35	30	29	27	18

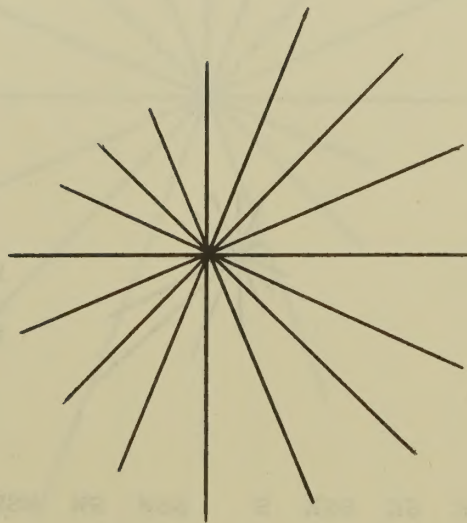


FIGURE 22
BARTON/SANFORD

Unit - ppb

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
25	34	36	35	34	36	37	35	34	30	26	26	25	21	20	20

POLLUTION ROSES - NITRIC OXIDE - 1983

0 20 40 60 ppb

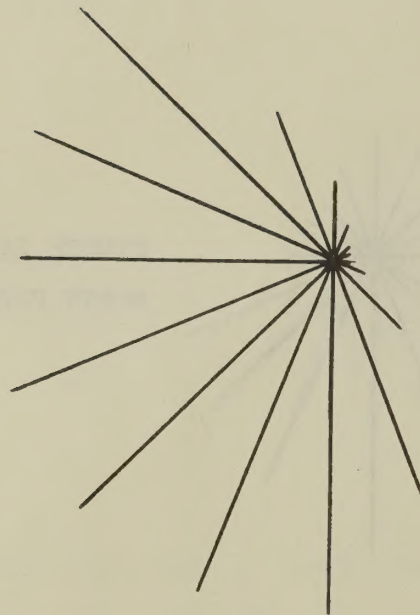


FIGURE 23
NORTH PARK

Unit - ppb

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
20	10	6	4	4	9	23	64	90	91	89	88	80	83	92	40



FIGURE 24
BARTON/SANFORD

Unit - ppb

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
16	18	16	13	21	36	50	28	21	15	13	14	10	7	11	16

POLLUTION ROSES - 1983

Carbon Monoxide

0 .5 1.0 1.5 ppm

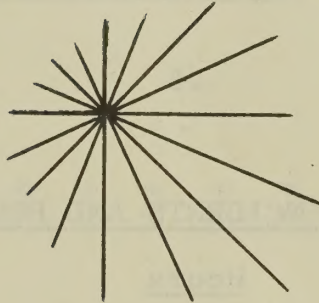


FIGURE 25

BARTON/SANFORD

Unit .1 ppm

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
6	7	10	12	12	15	16	13	12	9	7	7	6	5	5	5

Ozone

0 5 10 15 ppb

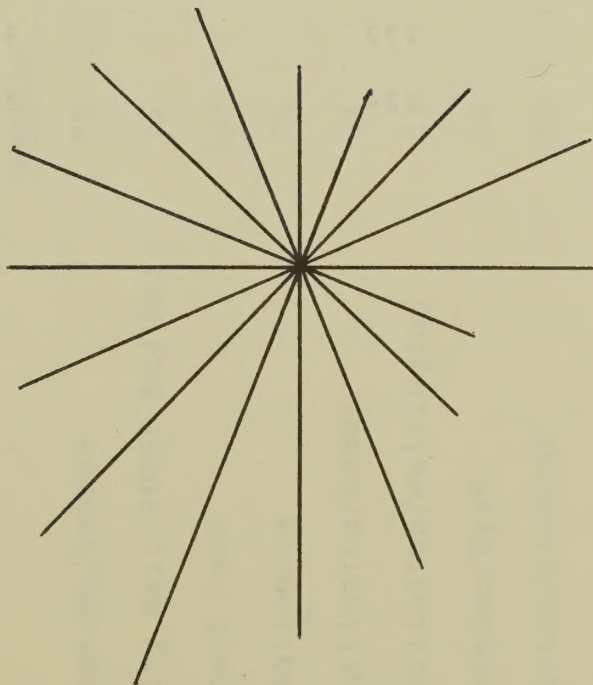


FIGURE 26

BARTON/SANFORD

Unit ppb

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
13	12	16	20	19	12	14	21	24	29	24	20	19	20	19	18

TABLE 1
AIR POLLUTION INDEX - 1983
OCCASIONS WHEN 32 OR ABOVE

<u>Date</u>	<u>No. of Hours > 32</u>	<u>Maximum</u>
1. March 1 - 2	26	37

NUMBER OF INCIDENTS AND HOURS ABOVE 31

	<u>Number</u>	<u>Hours</u>	<u>Maximum</u>
1983	1	26	37
1982	13	203	39
1981	8	118	38
1980	5	71	40
1979	22	485	55
1978	7	93	43
1977	9	201	44
1976	7	122	40
1975	10	126	36

TABLE 2a

SUSPENDED PARTICULATES - 1983

UNIT - MICROGRAMS PER CUBIC METER
unless otherwise specifiedONTARIO OBJECTIVES: 24 hour - 120
1-year Geo. Mean - 60

	No. of Samples	Geometric Mean		Maximum	% of Samples Above 120
		1983	1982 1981		
29001 - Hughson/Hunter	55	64	67 63	188	11
29007 - City Hall/29098 Bay Main	55	61	60 57	211	9
29008 - North Park	337	73	80 72	298	22
29009 - Kenilworth	55	55	63 64	229	2
29011 - Burlington/Leeds	54	95	92 101	254	31
29012 - Burlington/Wellington	52	68	73 63	195	15
29017 - Chatham/Frid	56	80	82 75	214	18
29025 - Barton/Sanford	328	75	82 72	282	17
29067 - 450 Hughson St. N.	56	47	53 56	127	4
29085 - Mountain Police Station	56	57	57 55	183	4
29087 - Cumberland	57	61	58 64	191	5
29089 - Barton/Nash	47	57	60 59	149	2
29090 - Westdale Library	53	50	55 59	131	4

TABLE 2b

MCMASTER UNIVERSITY SAMPLING - 1983

SUSPENDED PARTICULATES

UNIT MICROGRAMS PER CUBIC METER
unless otherwise specifiedONTARIO OBJECTIVES: 24-hour average - 120
1-year Geo. Mean - 60

LOCATION	No. of Samples	Geometric Mean		Maximum	% of Samples Over 120
		1983	1982		
San Diego Court	56	42	42	116	0
Upper Ottawa/Mohawk	58	39	39	112	2
Whitney/Rifle Range	59	40	50	124	2
Pottruff/Queenston	58	40	42	125	2
McElroy/Upper Wellington	58	49	56	173	5
Queensdale/Green Meadow	57	54	53	184	4
Westmount	58	44	45	153	3
Bishopgate/Ranchdale	54	45	42	145	2
Dundurn Castle	55	43	49	122	2
Centennial Pkwy./Violet Drive	42	54	57	123	2
Woodward/Brampton	46	58	64	137	7

TABLE 2c CONSTITUENTS IN SUSPENDED PARTICULATE ($\mu\text{g}/\text{m}^3$)

Station and Year	CADMIUM				CHROMIUM				IRON				LEAD				MANGANESE			
	Criterion: 2.0(24 Hours)				Criterion: 5.0(24 Hours)				Criterion: 5.0(24 Hours)				Criterion: 5.0(24 Hours)				Criterion: 5.0(24 Hours)			
	# of Samples	Geo. Mean	Max.		# of Samples	Geo. Mean	Max.		# of Samples	Geo. Mean	Max.		# of Samples	Geo. Mean	Max.		# of Samples	Geo. Mean	Max.	
29001	58	.001	.009		58	.003	.052		58	1.4	10.9		58	0.4	1.7		58	.08	3.24	
1980	59	.001	.006		59	.005	.140		59	1.5	21.6		59	0.4	1.2		57	.07	.86	
1981	55	.001	.008		55	.004	.039		52	1.2	17.8		52	0.3	1.1		55	.08	.62	
1982	55	.001	.028		55	.004	.039		55	1.4	13.2		55	0.3	1.4		55	.06	.70	
29008	313	.001	.018		345	.011	.089		343	4.3	35.3		347	0.6	1.9		346	.29	2.32	
1980	324	.001	.009		323	.008	.097		324	2.8	22.3		326	0.6	2.3		325	.17	1.50	
1981	330	.001	.005		327	.006	.091		309	2.7	16.3		338	0.4	1.8		330	.15	.89	
1982	337	.001	.006		337	.004	.045		337	2.4	15.4		330	0.4	2.4		337	.15	.98	
29011	57	.001	.012		57	.025	.080		57	5.5	30.6		57	0.6	1.8		57	.47	1.58	
1980	69	.002	.011		69	.021	.420		69	4.5	31.2		69	0.4	1.3		69	.32	1.85	
1981	57	.001	.016		57	.014	.078		57	3.8	42.0		54	0.3	1.7		57	.21	1.54	
1982	54	.001	.004		54	.013	.056		54	4.5	19.3		54	0.3	1.0		54	.28	.98	
29012	54	.001	.005		54	.007	.044		54	2.0	10.1		54	0.3	0.7		54	.15	.79	
1980	68	.001	.007		68	.006	.030		68	1.4	8.7		68	0.2	0.9		68	.11	.67	
1981	59	.001	.012		58	.008	.051		58	1.7	11.5		55	0.3	1.1		59	.11	.55	
1982	52	.001	.005		52	.003	.028		52	1.6	9.9		52	0.2	1.2		52	.10	.61	
1983																				

See Table 2a for location identification

TABLE 2c CONSTITUENTS IN SUSPENDED PARTICULATE (ug/m³)

Station and Year	CADMIUM				CHROMIUM				IRON				LEAD				MANGANESE			
	Criterion: 2.0(24 Hours)												Criterion: 5.0(24 Hours)							
	# of Samples	Geo. Mean	Max.		# of Samples	Geo. Mean	Max.		# of Samples	Geo. Mean	Max.		# of Samples	Geo. Mean	Max.		# of Samples	Geo. Mean	Max.	
29017																				
1980	55	.001	.005	55	.006	.047	9.6	55	2.2	0.3	1.5	55	0.3	1.5	55	.10	1.84			
1981	57	.001	.007	57	.005	.086	28.1	57	1.9	0.3	2.6	57	0.3	2.6	57	.09	2.05			
1982	59	.001	.009	59	.005	.047	19.5	52	2.1	0.3	3.0	58	0.3	3.0	59	.09	.76			
1983	56	.001	.004	56	.004	.027	8.4	56	2.0	0.2	1.8	57	0.2	1.8	56	.10	.43			
29025																				
1980	327	.001	.032	304	.009	.169	17.2	291	2.6	0.5	1.9	328	0.5	1.9	327	.18	9.77			
1981	317	.001	.023	317	.009	.103	32.9	317	2.3	0.6	3.1	317	0.6	3.1	316	.15	1.62			
1982	325	.001	.026	325	.008	.093	27.9	296	2.6	0.4	2.3	301	0.4	2.3	325	.14	1.22			
1983	328	.001	.020	327	.005	.100	15.3	328	2.2	0.3	2.5	328	0.3	2.5	328	.13	1.49			
29067																				
1980	55	.001	.038	55	.007	.054	14.8	55	1.8	0.3	1.2	55	0.3	1.2	55	.14	1.43			
1981	58	.001	.008	58	.006	.040	9.7	58	2.0	0.3	1.5	58	0.3	1.5	58	.08	.85			
1982	45	.001	.008	45	.007	.088	8.5	43	1.4	0.2	1.2	43	0.2	1.2	45	.09	.84			
1983	56	.001	.003	56	.002	.022	5.4	56	0.9	0.2	.5	56	0.2	.5	56	.05	.36			
29085																				
1980	57	.001	.006	59	.003	.109	12.6	59	1.1	0.3	0.9	59	0.3	0.9	59	.05	.75			
1981	55	.001	.004	54	.003	.057	14.6	55	1.2	0.3	1.3	55	0.3	1.3	54	.07	1.01			
1982	49	.001	.004	45	.003	.033	14.0	46	1.1	0.3	1.1	47	0.3	1.1	49	.06	.59			
1983	57	.001	.007	57	.001	.035	13.5	57	1.1	0.2	1.2	57	0.2	1.2	57	.06	.60			

See Table 2a for location identification

TABLE 2c CONSTITUENTS IN SUSPENDED PARTICULATE ($\mu\text{g}/\text{m}^3$)

Criterion: 2.0(24 Hours)				Criterion: 2.0 (24 Hours)											
NICKEL				VANADIUM				NITRATE				SULPHATE			
Station and Year	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.
29001															
1980	58	.004	.036	58	.01	.04	43	3.6	9.9	43	10.3	23.5			
1981	59	.002	.038	59	.01	.05	59	4.1	15.2	59	9.1	24.2			
1982	55	.002	.021	55	.01	.03	53	4.1	12.1	53	9.6	39.3			
1983	55	.002	.030	55	.00	.03	55	3.4	19.7	55	9.3	48.3			
29008															
1980	311	.006	.048	342	.01	.04	343	4.0	20.9	343	14.5	43.1			
1981	325	.005	.048	325	.01	.05	326	3.6	20.8	326	10.8	43.6			
1982	330	.003	.055	331	.01	.04	334	4.0	16.4	334	11.4	38.5			
1983	315	.002	.112	337	.00	.07	337	3.5	23.0	337	11.0	49.0			
29011															
1980	57	.011	.030	57	.01	.04	56	4.1	12.7	56	14.9	33.0			
1981	69	.007	.028	69	.01	.05	69	3.8	14.1	69	11.5	34.1			
1982	57	.005	.042	57	.01	.05	56	4.0	13.9	57	11.2	53.4			
1983	48	.004	.018	54	.01	.02	54	3.3	17.2	54	10.9	26.3			
29012															
1980	57	.004	.032	54	.01	.06	52	3.6	13.7	51	10.9	22.2			
1981	68	.003	.026	68	.01	.03	68	3.3	18.8	68	8.7	26.4			
1982	59	.004	.026	59	.01	.04	59	4.6	15.8	59	9.1	39.2			
1983	46	.003	.024	52	.00	.02	52	3.8	21.1	52	10.0	19.8			

See Table 2a for location identification

TABLE 2c. CONSTITUENTS IN SUSPENDED PARTICULATE (ug/m³)
Criterion: 2.0(24 Hours) Criterion: 2.0(24 Hours)

Station and Year	NICKEL			VANADIUM			NITRATE			SULPHATE		
	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.
29017												
1980	55	.007	.045	55	.01	.13	55	3.7	15.6	55	12.0	24.3
1981	57	.004	.055	57	.01	.08	57	4.0	17.9	57	10.3	28.6
1982	59	.006	.032	59	.01	.04	59	4.3	16.0	59	10.2	38.7
1983	47	.006	.037	56	.00	.05	56	3.8	18.5	56	10.0	24.2
29025												
1980	327	.010	.233	329	.01	.07	305	3.8	16.3	328	12.5	43.1
1981	317	.006	.051	317	.01	.08	317	3.3	25.0	317	9.5	41.0
1982	325	.006	.068	325	.01	.08	337	3.7	20.5	337	9.6	59.3
1983	328	.004	.041	328	.00	.04	328	3.7	21.6	328	10.1	31.8
29067												
1980	55	.007	.031	55	.01	.03						
1981	58	.002	.053	58	.01	.03						
1982	45	.006	.023	45	.01	.04						
1983	56	.002	.015	54	.00	.03						
29085												
1980	59	.003	.022	59	.01	.03	59	3.5	12.4	59	10.7	20.7
1981	55	.001	.023	53	.01	.03	55	3.7	14.2	55	9.3	27.6
1982	49	.002	.024	49	.00	.03	50	3.6	13.2	50	9.4	35.6
1983	57	.001	.013	56	.00	.05	57	2.8	15.1	57	8.5	24.9
29087												
1980							58	3.4	9.7	58	11.2	27.0
1981							58	3.3	11.9	58	9.2	24.4
1982							58	4.0	17.1	58	10.3	41.1
1983							57	2.9	16.2	57	8.8	20.8

See Table 2a for location identification

TABLE 3

SOILING INDEX - 1983
1-HOUR TELEMETERED INSTRUMENTS

UNITS - COH's per 1000 linear ft. of air

Ontario Objectives - 24-hour - 1.0
1-year - 0.5
No. of Times Above
Objective 24-hour

Maximum
24-hour

Annual Average
1982 1981 1980

1983

29008 - North Park

34

29025 - Barton/Sanford

13

TABLE 4

DUSTFALL 1983

UNITS - GRAMS/SQ. METRE/30 DAYS

Ontario Objectives - 1 month avg - 7.0
1 year ave - 4.5

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average		
													1983	1982	1981
29001 Hughson/Hunter	4.5	6.3	7.4	10.7	6.1	6.0	4.0	5.3	4.7	4.2	2.5	4.0	5.5	5.8 ¹¹	8.0 ¹¹
29006 Queenston	4.3	5.0	6.3	9.1	4.1	5.0	4.7	3.5	2.9	3.0	2.1	3.2	4.4	5.7	6.6
29008 North Park	6.8	8.5	6.5	11.2	10.1	9.2	9.6	10.6	10.1	11.2	7.8	16.4	9.8	11.6	12.8
29009 Kenilworth	3.2	5.6	5.7	7.4	4.8	5.3	4.1	4.1	2.9	3.8	1.9	3.0	4.3	5.8	5.5
29010 Burlington/ Ottawa	20.2	29.2	27.8	35.8	21.0	22.7	12.1	26.9	19.9	23.3	18.1	15.3	22.7	23.5	25.9
29011 Burlington/ Leeds	11.2	10.8	16.6	20.3	15.7	13.8	7.9	15.3	10.3	11.8	9.5	7.9	12.6	12.5	13.2
29012 Burlington/ Wellington	8.2	9.5	9.2	17.0	10.0	9.7	8.4	7.7	6.0	10.2	5.5	9.7	9.3	9.1	8.5
29017 Chatham/Frid	6.0	7.2	8.3	11.3	9.1	8.5	7.3	7.5	10.2	-	7.7	5.7	8.1 ¹¹	6.4 ¹¹	11.1 ¹¹
29025 Barton/Sanford	4.2	13.1	8.5	10.6	8.6	-	3.5	6.5	4.8	6.1	6.0	3.2	6.8	8.7	8.7
29030 Camden/Mohawk	3.4	3.7	3.8	7.7	7.4	6.7	5.3	4.8	1.7	3.8	4.0	3.7	4.7	5.1	5.8
29031 Concession/ Upper Sherman	6.2	11.7	9.4	10.2	6.8	12.0	5.4	7.0	4.6	-	6.4	7.0	7.9 ¹¹	7.2	6.9

TABLE 4 (con'd)
DUSTFALL 1983

UNITS - GRAMS/SQ. METRE/30 DAYS

Ontario Objectives - 1 month avg - 7.0
1 year avg - 4.5

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average 1983 1982 1981
29036 Roosevelt/ Beach Rd.	<u>15.5</u>	<u>22.4</u>	<u>13.0</u>	<u>19.8</u>	<u>17.5</u>	<u>13.4</u>	<u>11.1</u>	<u>12.5</u>	<u>11.9</u>	<u>18.3</u>	<u>21.9</u>	<u>14.2</u>	<u>15.1</u> <u>17.2</u> <u>11.8</u>
29037 Strathearn	<u>18.9</u>	<u>21.9</u>	<u>19.8</u>	<u>29.6</u>	<u>23.1</u>	<u>40.7</u>	<u>23.8</u>	<u>45.1</u>	<u>43.5</u>	<u>31.4</u>	<u>21.9</u>	<u>22.7</u>	<u>28.5</u> <u>23.9</u> <u>21.3</u>
29044 Wark/ Beach Blvd.	<u>5.6</u>	<u>4.6</u>	<u>5.7</u>	<u>11.0</u>	<u>9.5</u>	<u>10.7</u>	<u>11.2</u>	<u>11.8</u>	<u>9.9</u>	<u>10.6</u>	<u>7.7</u>	<u>5.8</u>	<u>8.7</u> <u>8.5</u> <u>8.2</u>
29082 Leaside Rd.	<u>3.8</u>	<u>4.0</u>	<u>4.3</u>	<u>11.5</u>	<u>7.7</u>	<u>7.1</u>	<u>10.8</u>	<u>8.4</u>	<u>6.2</u>	<u>7.0</u>	<u>6.3</u>	<u>6.8</u>	<u>7.0</u> <u>6.2</u> <u>9.8</u>
29084 Rembe/ Beach Blvd.	<u>5.8</u>	<u>3.9</u>	<u>4.7</u>	<u>8.1</u>	<u>4.4</u>	<u>8.4</u>	<u>11.2</u>	<u>12.1</u>	<u>9.7</u>	<u>11.6</u>	<u>7.0</u>	<u>7.1</u>	<u>7.8</u> <u>6.9</u> <u>8.1</u>

Underlined values are above objective. Exponents refer to number of months when less than 12 samples were collected.

TABLE 5

SULPHUR DIOXIDEUNITS - PARTS PER MILLION

Ontario Objectives: 1-hour - .25
 24-hour - .10
 1-year - .02

	Annual Average	Maximum		No. of Times Above 1-hour	Objective 24-hour
		1-hour	24-hour		
29008 - North Park	1983	.11	.06	0	0
	1982	.17	.05	0	0
	1981	.12	.07	0	0
	1980	.13	.07	0	0
29025 - Barton/ Sanford	1983	.15	.04	0	0
	1982	.18	.05	0	0
	1981	.14	.06	0	0
	1980	.16	.06	0	0

TABLE 6

TOTAL REDUCED SULPHUR

UNITS - PARTS PER BILLION

Ontario Objective: 1-hour - 20 (Hydrogen Sulphide)

	Annual Average	Maximum - 1 hour	No. of Hours Above Objective
29008 - North Park			
1983	1.2	30	9
1982	2.1	122	49
1981	1.6	47	35
1980	1.8	44	26
29025 - Barton/ Sanford			
1983	1.4	48	30
1982	1.2	111	32
1981	1.3	83	46
1980	0.9	61	26

TABLE 7

CARBON MONOXIDE

UNITS - PARTS PER MILLION

Ontario Objective: 1-hour - 30
8-hour - 13

	Annual Average	Maximum		No. of Times Above Objective	
		1-hour	8-hour	1-hour	8-hour
29025 - Barton/ Sanford	1983	0.9	12	6	0
	1982	1.1	10	5	0
	1981	1.2	15	8	0
	1980	0.9	10	4	0

NITROGEN DIOXIDE

UNITS - PARTS PER MILLION

Ontario Objectives: 1-hour - .20
24-hour - .10

	Annual Average	Maximum		No. of Times Above 1-hour	Objective 24-hour
		1-hour	24-hour		
29008 - North Park	1983	.14	.07	0	0
	1982	.10	.07	0	0
	1981	.24	.08	3	0
	1980	.15	.10	0	0
29025 - Barton/ Sanford	1983	.10	.08	0	0
	1982	.11	.08	0	0
	1981	.15	.08	0	0
	1980	.15	.06	0	0

TABLE 9

NITRIC OXIDE

UNITS - PARTS PER MILLION

	Annual Average	Maximum 1-hour 24-hour
29008 - North Park		
1983	.057	.53 .21
1982	.052	.59 .19
1981	.061	.67 .27
1980	.065	.52 .16
29025 - Barton/ Sanford		
1983	.018	.45 .17
1982	.024	.44 .16
1981	.024	.83 .29
1980	.021	.43 .13

TABLE 10

OZONE

UNITS - PARTS PER BILLION

Ontario Objective: 1-hour - 80

	Annual Average	No. of Hours	
		Maximum - 1 hour	Above Objective
29025 - Barton/ Sanford	18.7	111	61
	16.9	88	4
	16.3	89	15
	17.4	107	24

TABLE 11
FLUORIDATION RATE - 1983
ALL VALUES IN MICROGRAMS/100 SQ. CM/30 DAYS

Ontario Criteria: April 15 to October 15 - 40 October 16 to April 14 - 80															
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average		
													1983	1982	1981
29001 Hughson/Hunter	17	24	62	59	37	47	24	51	26	36	-	33	38	36	32 ¹¹
29012 Burlington/ Wellington	46	22	33	36	29	32	22	41	20	39	37	34	33	33	28
29025 Barton/Sanford	27	40	98	65	45	52	33	73	36	55	63	32	52	50	33
29054 Beach Rd./ Conrad	52	46	51	89	46	32	59	49	39	40	97	40	53	51 ¹¹	67
29058 Q.E.W./Skyway	93	71	80	120	102	79	122	103	156	109	93	127	105	126 ¹¹	110
29059 Burlington/ Gage	57	77	185	64	73	86	72	102	55	89	90	64	84	108	90
29062 Briarwood School/King St.E.	26	27	46	46	68	45	54	59	36	42	68	27	45	44	77
29066 Killarney/ Beach B.	52	44	37	121	45	44	57	41	71	48	64	103	61	67	56

Underlined values are above objective. Exponents refer to number of months when less than 12 samples were collected.



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